

Light level to electrical frequency conversion with hybrid optical bistable devices

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Abstract

A new concept in light level detection. The basis is the use of hybrid optical bistable devices working in oscillatory mode. The obtained instabilities show a correspondence between their frequency and the laser light intensity.

Introduction

As it is known from the literature¹, several modes of operation can be obtained in hybrid bistable optical devices (HBOD), merely selecting a specific set of operating conditions. Optical memories and optical logic elements have been reported²; moreover optical instabilities can be achieved³. We have extended some of these results to the conversion of light level intensity into an electrical signal of variable frequency.

Experimental

The system is based on the use of a HBOD employing liquid crystals as nonlinear material. If the system operates in the way previously reported³, several oscillating signals can be obtained, the frequency being dependent on the feedback amplification factor (β) as well as on the input light level (I_{in}) for fixed value of bias voltage (V_B), and cell's angles (θ and α).

Fig. 1 gives an schematic diagram of the HBOD employed.

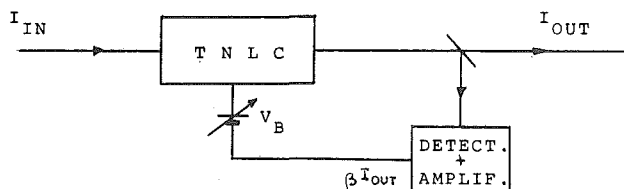


Figure 1. Hybrid optical bistable system

The main point concerning this arrangement is the electrooptic light intensity modulator, in our case, a twisted nematic liquid crystal cell. When this cell is orthogonal to the incident laser beam, its transmission curve, as a function of the cell applied voltage, is the one shown in Fig. 2, for 0° . In this case, polarizers are crossed. But when the cell is forming two angles, Fig.3, with the input beam direction, this transmission no longer verifies.

The experimental results give the appearance of several maxima and minima. For $\theta = 45^\circ$ and $\alpha = 0^\circ$ the new transmission curve is shown in Fig.2. This curve has been obtained for the static case. When the applied voltage is varying with time, its shape changes to a more complex form.

With the above considerations, the final set up is shown in Fig.4.

The light, after crossing the liquid crystal cell and a crossed polarizer, impinges on a phototransistor, in our case a TIL 78, working as a current source. The obtained current is a function of the output intensity level. Feedback is obtained through the variable resis-

tor R . Its value gives the feedback coefficient.

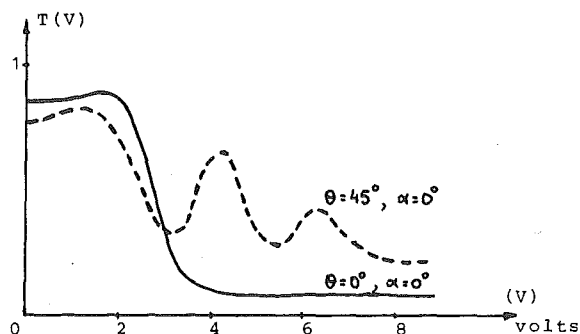


Figure 2. Optical transmission versus voltage in T.N. cells with crossed polarizers.

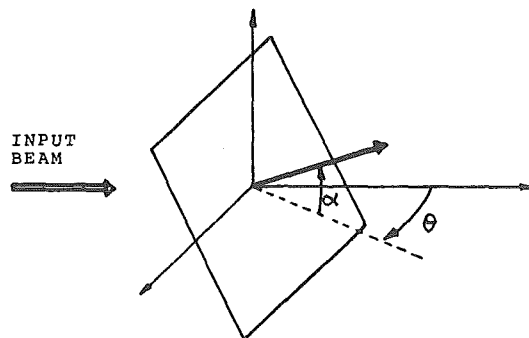


Figure 3. Orientation of the TNLC cell.

Instabilities are obtained for certain sets of conditions given elsewhere⁴.

A system to detect gray-levels has been developed with this scheme. Different values for θ , α , V_B and β yield different output conditions.

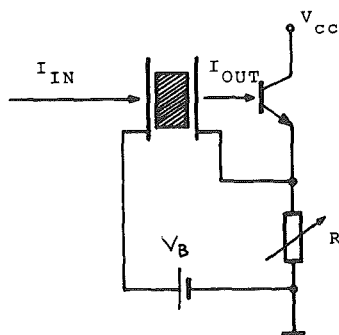


Figure 4. Experimental setup.

Fig.5 shows the results for the case $\theta=0^\circ$, $\alpha=0^\circ$, $V_B=2$ volts and $\beta=1$ v/mW. A 5 mW He-Ne laser beam was used as input signal. A variable attenuator was employed at the input system to control the light level impinging on the optical bistable device. The value of the fundamental frequency of the obtained signal is represented as a function of the light level where $l=100$ corresponds to no attenuation and $l=0$ to total darkness.

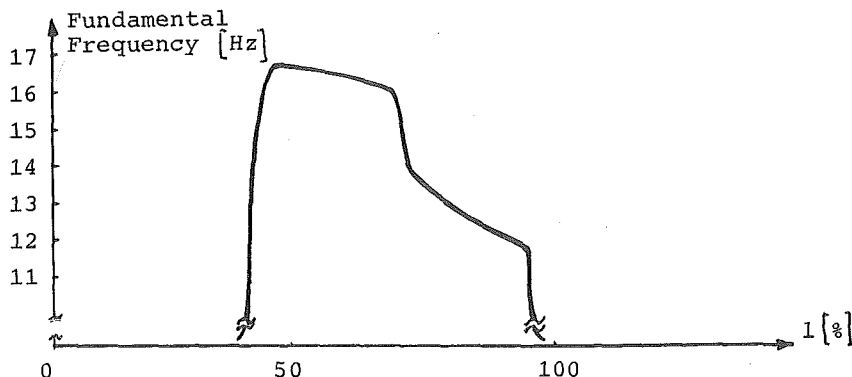


Figure 5. Fundamental Frequency of the output signal

As it can be seen light levels between values for 1 of 45 and 90 can be differentiated from the different optical oscillating outputs, for this particular case.

Conclusions

This method can be applied to gray-level thresholding. The corresponding spectra for the different output signals have been studied showing some more information not given just with the fundamental frequency. This system could be applied to target detection.

References

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